Space Weather Technical Forecast

Issued on Tuesday, 30 May 2023 at 01:23 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: R1/R2 radio blackouts likely at times throughout. Active electron fluence likely Days 3-4. Slight chance of isolated G1/Minor storm intervals.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Low with frequent C-Class flares, and a peak of C6.5 at 29/1829UTC from AR3310. There are currently 10 numbered and 2 unnumbered regions on the visible disc. AR3315 (Eki/Beta-Gamma-Delta) remains the largest region on the disc and has recently developed a small delta spot in the trailing region. Recently numbered AR3317 and AR3318 continue to grow and develop in complexity. All other regions on the disc are either small or simple.

No Earth-directed CMEs were observed on available imagery during the period.

Solar Wind / Geomagnetic Activity: Solar winds observed by ACE at L1 have remained predominantly at ambient levels 360-400 km/s. Density has been below average (<5 ppcc). The total interplanetary magnetic field strength has been weak, at or below 6 nT. The north-south component has weakly fluctuated between +5/-5 nT. The phi angle was mostly negative (towards the Sun). Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV at GOES-16) has remained at background levels throughout. High energy electron flux (greater than 2MeV at GOES-16) also remained at background levels. The associated 24 hour fluence has been below Active (above 1e8 integrated pfu) with a peak of 1.24e7 integrated pfu at 29/0300 UTC. Electron fluence observed at 30/0000UTC was 7.15e6 integrated pfu.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is expected to remain Low to Moderate. There is a slight chance of X-class flaring throughout, mainly from large and complex AR3315 in the southwestern quadrant.

Solar Wind / Geomagnetic Activity: A CME that left the Sun on 26 May could give a glancing blow at Earth on Day 2 (31 May) or possibly Day 3 (01 Jun). A HSS from CH08/+ may connect with Earth later on Day 3 or Day 4 (01-02 June). Solar winds are likely to remain at ambient or slightly elevated levels, with a chance of becoming elevated by Day 4 should the HSS connect with Earth. Geomagnetic activity is expected to be mainly Quiet to Unsettled (Kp0-3), but with a chance of Active, and slight chance G1/Minor Geomagnetic Storm intervals through the period due to possible CME impacts or a CH HSS arrival by Day 4.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at background levels, however there remains a slight chance of reaching the S1/Minor Storm threshold should any larger flares occur. High energy electron flux (greater than 2MeV) is expected to remain largely below the high threshold but with an increasing chance of reaching High levels during the diurnal maximum. The possible CME arrival and high speed stream connection could generate enough geomagnetic activity to reduce electron counts but

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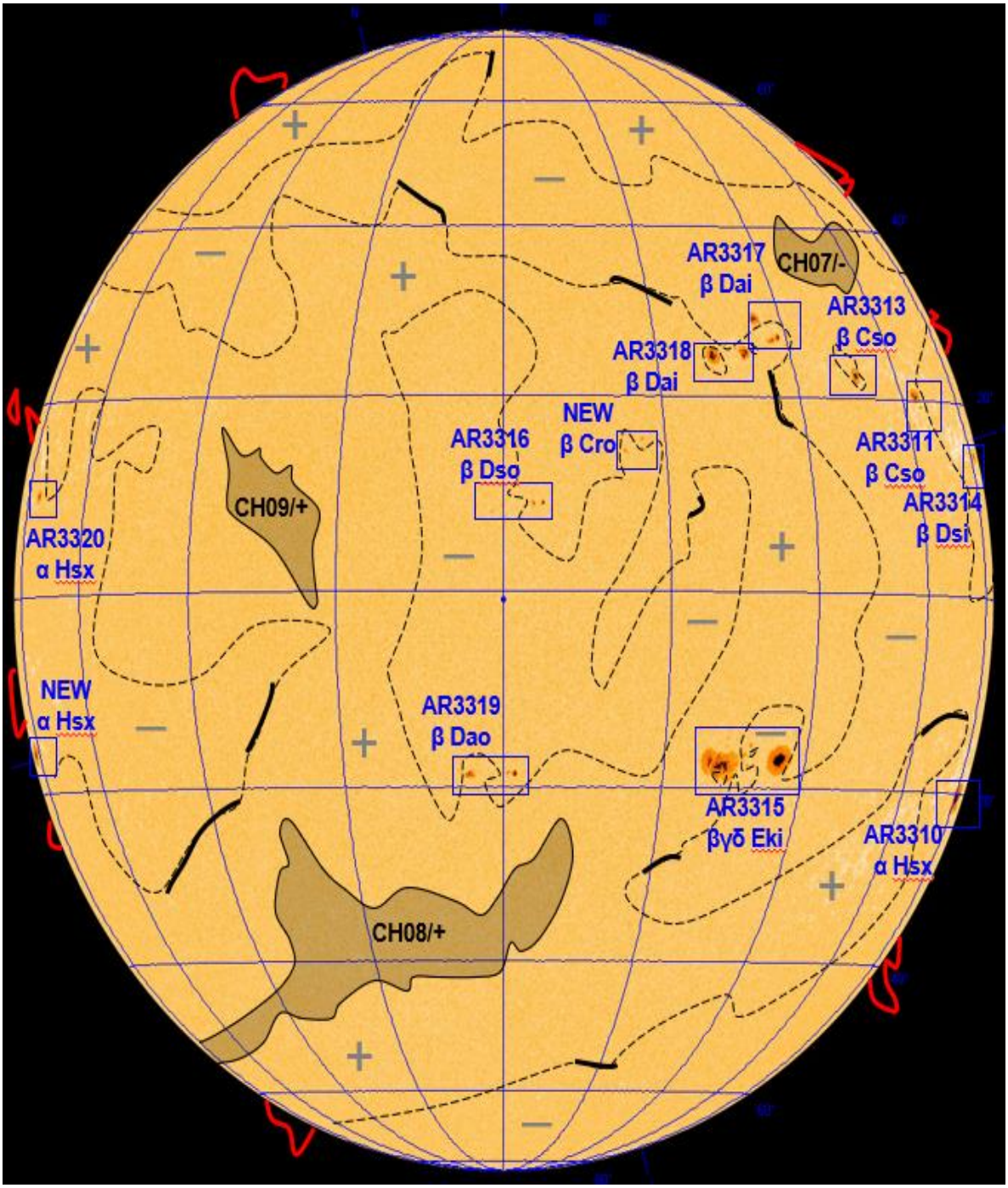
with limited confidence. Electron fluence values may return to above the Active (1e8 integrated pfu) threshold by Day 2 (31 May), but there is low confidence later in the period due to the uncertainty of modifying factors.

Figure 1. Solar Analysis Valid 29/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth-directed CMEs have been observed on available imagery over the past 24-hours. However, a number of Enlil ensemble members support the arrival at Earth on Day 2-3 (31 May-01 June) of a glancing blow from a CME that left the Sun on 26 May, although much of this feature is directed southward.

Solar winds are likely to be remain ambient or slightly elevated levels, perhaps with a slight but waning enhancement from a recent HSS from CH07/-. CH07/- is similar in shape and position when compared to the last rotation, persistence would suggest that the high speed stream may result in peak speeds of around 500km/s, although this is not currently reflected at STEREO-A. A HSS from CH08/+ in the southeast of the disc is expected to connect on either Day 3 or 4 (01-02 Jun).

Geomagnetic activity is expected to be mainly Quiet to Unsettled, but with a chance of Active, and a slight chance G1/Minor Storms through the period due to possible CME impacts or the connection to either a CIR or the HSS on Day 3 or 4.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	20	20	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil currently expected. Glancing blow possible, for details see ‘Geomagnetic Storms’ section above.

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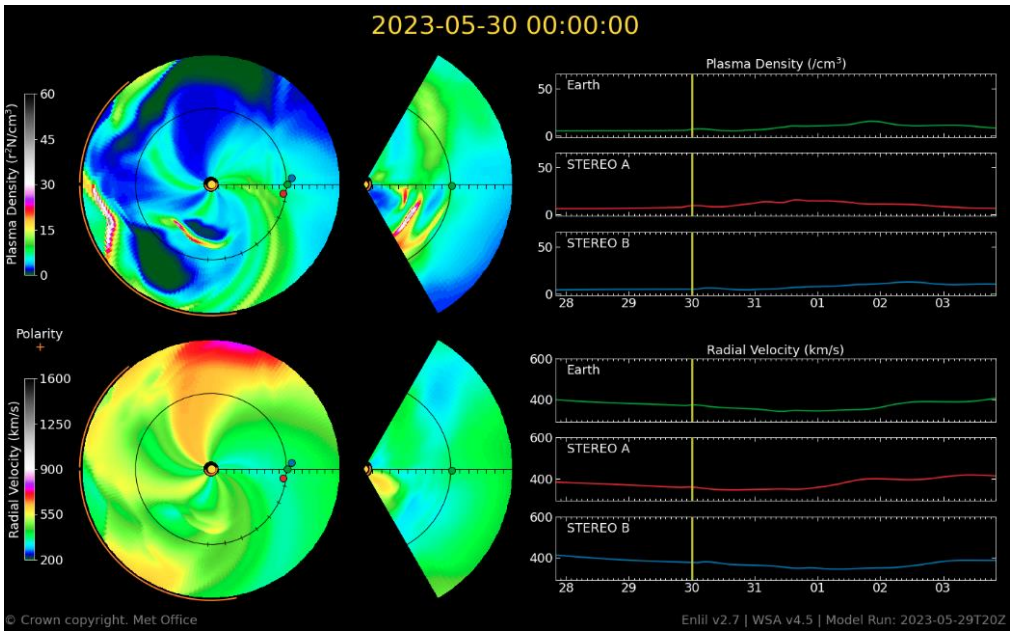
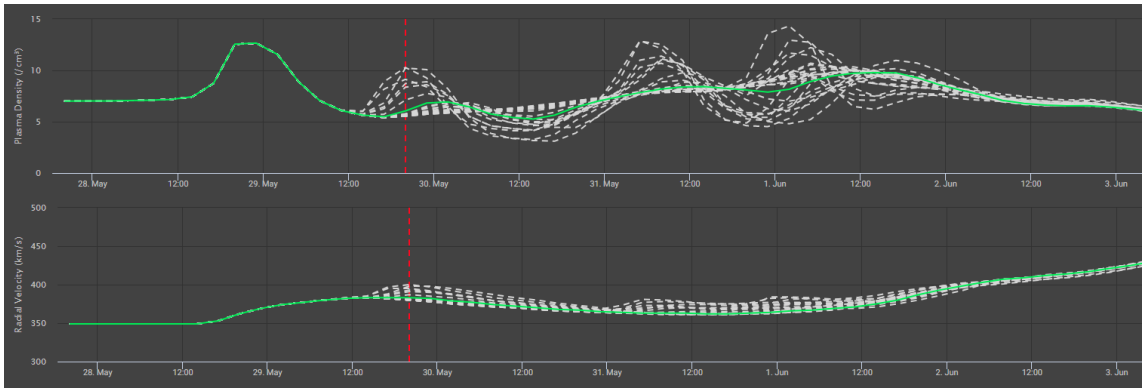
Figure 2: MOSWOC Enlil and Ensemble indicating potential glancing blow from a CME, and connection to HSS through Days 3-4.





Radio Blackouts - X-Ray Flares:

Solar activity has been Low over the past 24 hours, with frequent C-class flares and a peak of C6.5 at 29/1829 UTC from departing region AR3310.

There are currently 10 numbered and 2 unnumbered regions on the visible disc. AR3315 (Eki/Beta-Gamma-Delta) remains the largest region on the disc and has recently developed a small delta spot in the trailing region. Recently emerged and numbered AR3317 and AR3318 continue to grow and develop in complexity. AR3311 has decayed further. The viewing angle of AR3314 reduces confidence in assessment of its classification, and is due to rotate off of the disc during Day 1 (30 May).

All other regions on the disc are either small or simple and have displayed little change. AR3320 and an unnumbered region are gradually rotating across the eastern limb, as these regions rotate further onto the disc the improved viewing angle will result in more confident classification.
Isolated M-class flares are considered likely through the forecast period, mainly due to the complex regions in the western hemisphere, with a slight chance of an X-flare.
Several regions, some of which may have been responsible for significant activity as they tracked across the far-side, are due to rotate onto the eastern limb over the next few days and are expected to lead to an increase in solar activity.

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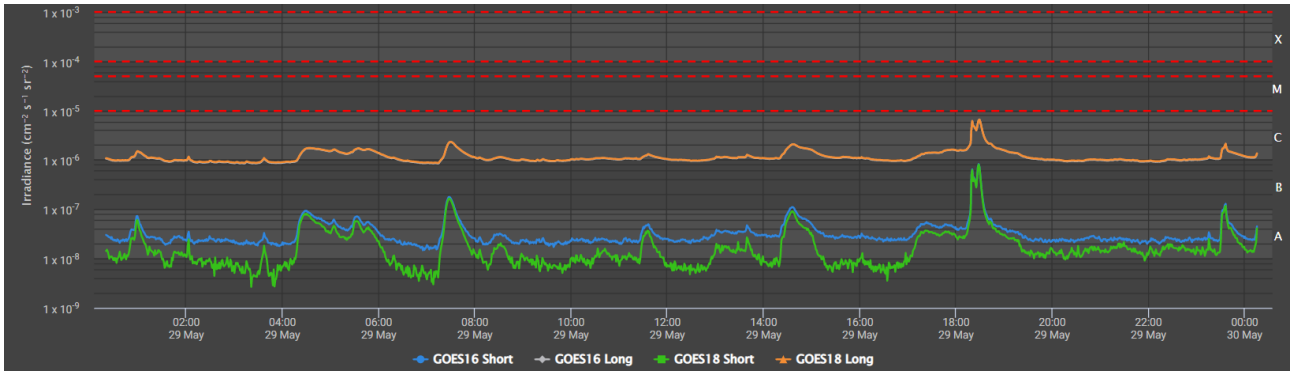
X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	60	60	65
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: GOES 16 & GOES 18 X-Ray Flux Trace



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES16, is at background levels. There is a slight chance of S1/Minor Radiation Storming, should any larger flares occur. AR3315 remains the most likely source region as it continues to transit the southwestern hemisphere.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	20	20	20	20
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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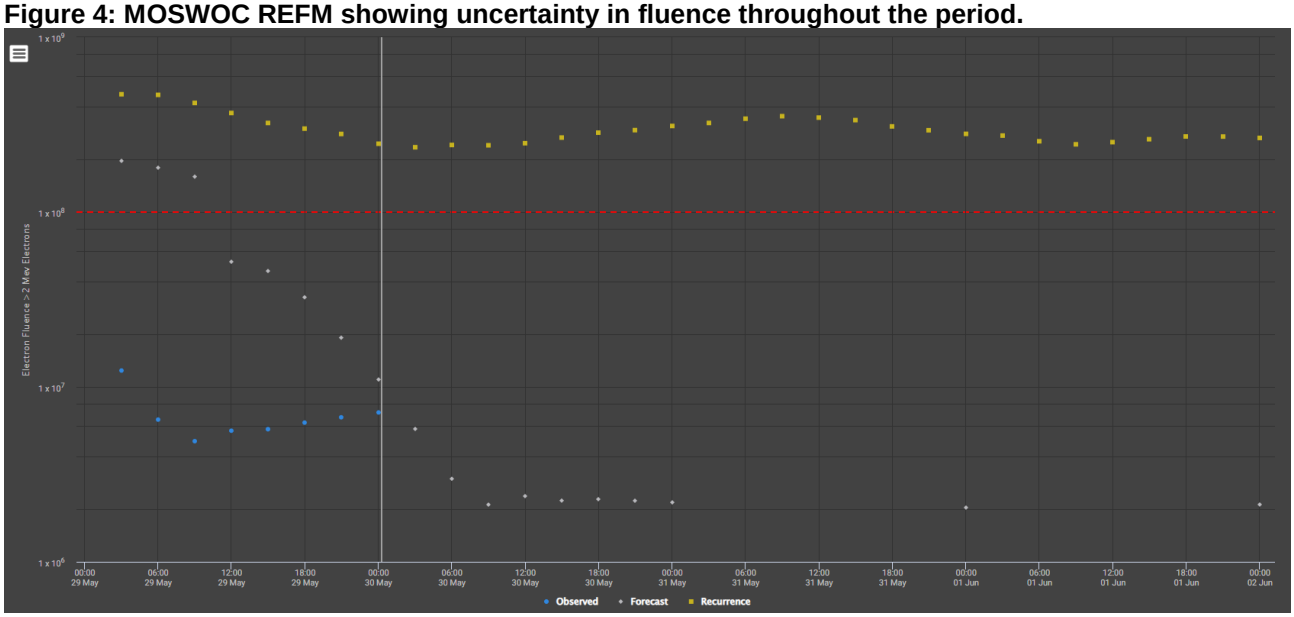
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) has been at Background to Moderate levels. Through the period it is increasingly likely to return to High levels during the diurnal maximum, in the absence of any modifying factors, particularly later in the forecast. The most likely source of any geomagnetic activity is from a CME on Days 2-3 (31 May -01 Jun), although this is expected to largely pass below the Earth, resulting in limited geomagnetic activity. There is a chance that a coronal hole HSS may connect at Earth on Day 3 or 4 (01-02 June) which may act to suppress the observed flux levels.

There is a chance that associated 24 hour fluence may recover to above Active (1e8 integrated pfu) by Day 2 (31 May). However, there is low confidence in the forecast, with REFM showing a large spread in possible fluence values. The increase in probabilities later in the forecast reflects the uncertainty with geomagnetic activity and the charging and relaxing of electron belts during the period.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	30	40	50	30
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: MOSWOC REFM showing uncertainty in fluence throughout the period.



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